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Therapy-induced plasticity in three patients with chronic nonfluent aphasia and apraxia of speech

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Introduction

Based on our recent fMRI-studies with 30 healthy control subjects, we gained an insight into the involvement of neuroanatomical structures which contribute to rhythmic singing with differently demanding complexity levels as it is applied in the evidence-based rhythmic-melodic voice training SIPARI® developed for language rehabilitation.
Difficulties with temporal coordination or sequencing of speech movements are frequently reported in aphasia patients with concomitant apraxia of speech (AOS). Therefore, our objective was to investigate if these patients also benefit from this treatment and how improvements in language and speech-motor performance correlate with changes in brain activation.

Methods

Patients:
3 patients with severe chronic nonfluent aphasia and AOS (1 Broca's, 2 global aphasia patients) were included in this therapy study. Changes in language and speech-motor performance were examined before and after therapy by combining cognitive and neural methods.
Stimuli:
Patients underwent the same fMRI-procedure as 30 healthy control subjects in our pre-study (Jungblut et al. 2012) in order to investigate if changes in brain activation occur due to improved temporal sequencing. Stimuli consisted of quadruple measure groupings with a duration of 4 sec. (1 beat per sec.; 8 vowels alternately /a/i/) sung at a frequency of 220 Hz (A3) with differing rhythm structure (1) regular, (2) regular with rests, (3) irregular. Stimuli were presented by fMRI compatible headphones (Resonance Technology).
Task:
The experiment was conducted in an event-related design. Stimuli were presented in a pseudo-randomized order and jittered around an interstimulus interval (ISI) of 9 sec. Patients had to listen and to immediately repeat the heard stimuli after the presentation had stopped. Their vocal production was recorded and analyzed.
Data Acquisition:
The study was performed on a 3T Siemens Trio MRI-system. We used a T2*-weighted EPI sequence (TR 2200ms, TE 30ms, FA 90°); 41 transversal slices with a thickness of 3.4 mm were acquired covering the whole brain.
Data Analysis:
Imaging data were analyzed using SPM8. Functional data were derived from random effects analysis with an FDR-corrected p-value of p=0.05 and an extend threshold of 5 voxel for each single subject.

References

- Bradt, J., Magee, W.L., Dileo, C., Wheeler, B.L. & McGilloway, E. et al. (2010), 'Music therapy for acquired brain injury' [Review], Cochrane Database of Systematic Reviews, 7, 1-42.
- Breier, J.I., Juranek, J., Maher, L.M., Schmadeke, S., Men, D. & Papanicolaou, A.C. (2009), 'Behavioral and neurophysiologic response to therapy of chronic aphasia,' Archives of Physical Medicine and Rehabilitation, 90 (12), 2026-2033.
- Cardebat, D., Demonet, J.F., De Boissezon, X., Marie, N., Marie R.M., Lambert, J., Baron, J.C. Puel, M. (2003), 'Behavioral and neurofunctional changes over time in healthy and aphasic subjects: a PET language activation study,' Stroke, 34, 2900-2906.
- Crosson, B., McGregor, K., Gopinath, K.S., Conway, T.W., Benjamin, M., Chang, Y.L., Bacon Moore, A., Raymer, A.M., Briggs, R.W., Sherod, M.G., Wierenga, C.E. & White, K.D. (2007), 'Functional MRI of language in aphasia: a review of the literature and the methodological challenges,' Neuropsychology Review, 17, 157-177.
- Jungblut, M. (2009), 'SIPARI® A music therapy intervention for patients suffering with chronic, nonfluent aphasia', Music and Medicine, 1 (2), 102-106.
- Jungblut, M., Suchanek, M. & Gerhard, H. (2009), 'Long-term recovery from chronic global aphasia: A case report,' Music and Medicine, 1 (1), 61-69.
- Jungblut, M., Huber, W., Pustelniak, M., Schnitker, R. (2012), 'The impact of rhythm complexity on brain activation during simple singing - an event-related fMRI study,' Restorative Neurology and Neuroscience, 30 (1), 39-53.

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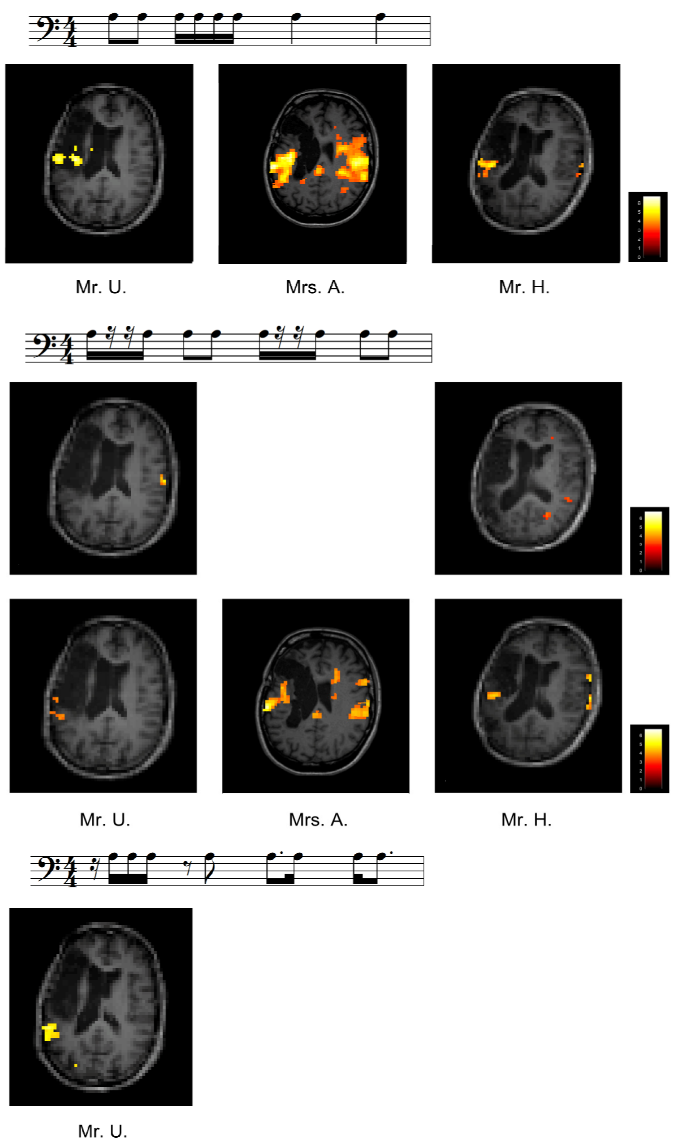
Results



For all patients clinically significant improvements could be assessed in final language and motor-speech tests. Analyses of the recorded data demonstrated that all patients improved significantly in their temporal sequencing performance.
A main finding was that post-minus pre-treatment imaging data yielded peri-lesional activations in all patients e.g. in the left superior temporal gyrus, whereas the reverse subtraction revealed either no significant activation or right hemisphere activation.
While post- minus pre-treatment results of the Broca's aphasia patient demonstrated exclusively left-hemisphere activation in peri-lesional regions, post- minus pre-treatment data of both global aphasia patients yielded activations in peri-lesional regions as well as in homologous areas in the right hemisphere.
A correlation could be found between improvements in temporal sequencing and intensity of activation and recruitment of a neural network that we previously found in our study with healthy control subjects e.g. inferior frontal gyrus, insula, and basal ganglia.

Discussion

Based on our results, we assume that an improvement of short-term storage of sub-lexical material and, as a result of this, improved temporal sequencing possibly represents a basis for improved speech-motor processing but also for significant improvements of language capabilities.
Functional reintegration of the left superior temporal gyrus is mentioned in the literature in connection with language improvement. However, these research reports refer to language therapy interventions.
Our results suggest that especially in the treatment of severely impaired chronic aphasia patients with concomitant AOS the applied rhythmic-melodic voice training SIPARI® can be very effective because it aims at improving specific language but also cognitive capacities.

Reprints are available at: http://www.Sipari.de/posters/
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